Aug. 9, 1932. A. E. NASH 1,870,783

FURNACE WALL STRUCTURE

Filed May 18. 1928 3 Sheets-Sheet 1

Fig. 1.

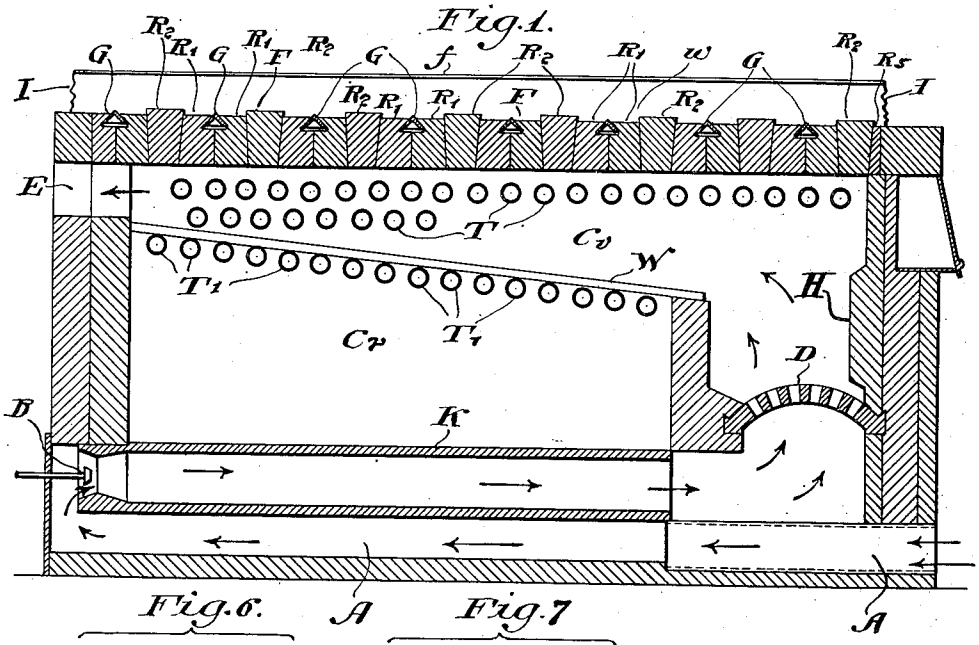


Fig. 6.

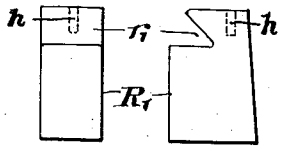


Fig. 7

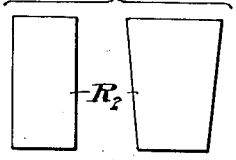




Fig. 8.

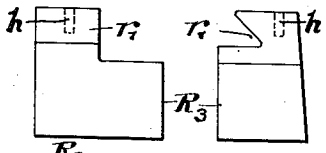


Fig. 9

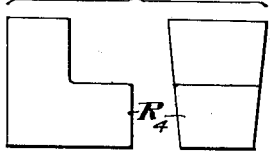
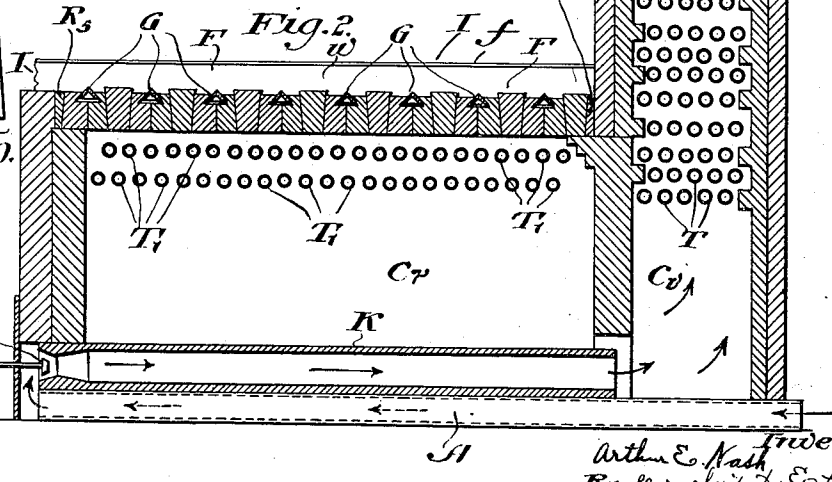




Fig. 10.

Fig. 2.



Inventor
Arthur E. Nash
By Cornelius D. Ebel
his Attorney

Aug. 9, 1932. A. E. NASH 1,870,783

FURNACE WALL STRUCTURE

Filed May 18. 1928 3 Sheets-Sheet 2

Fig. 3.

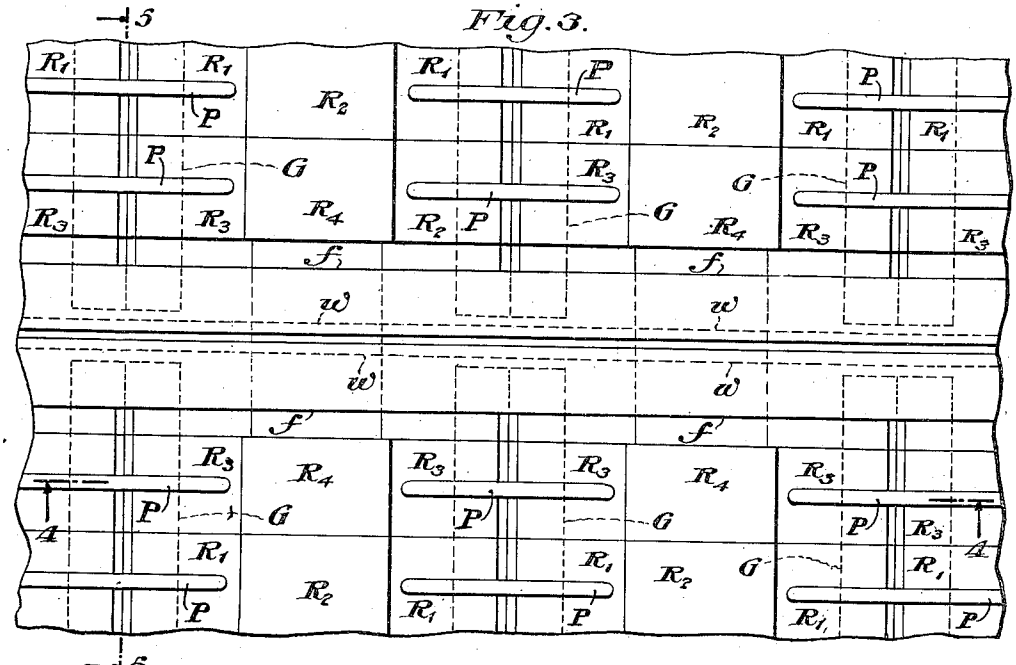


Fig. 4.

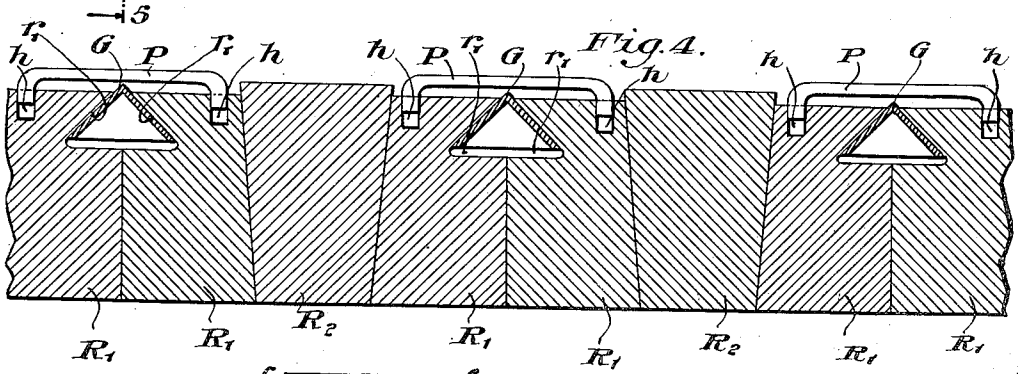
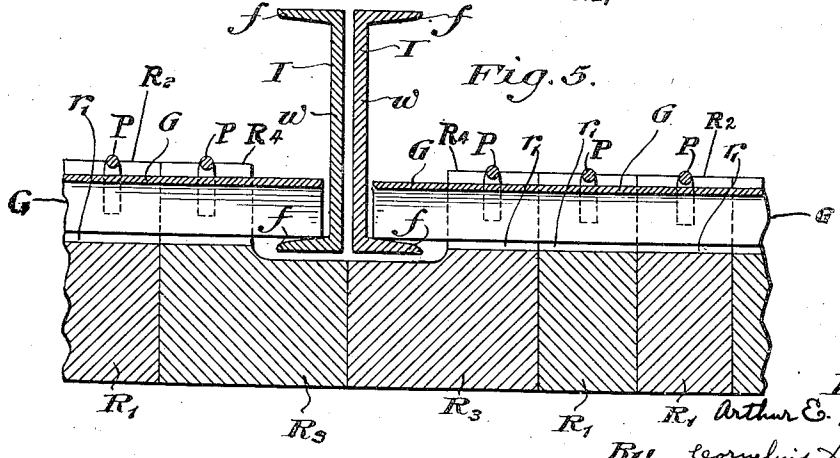


Fig. 5.



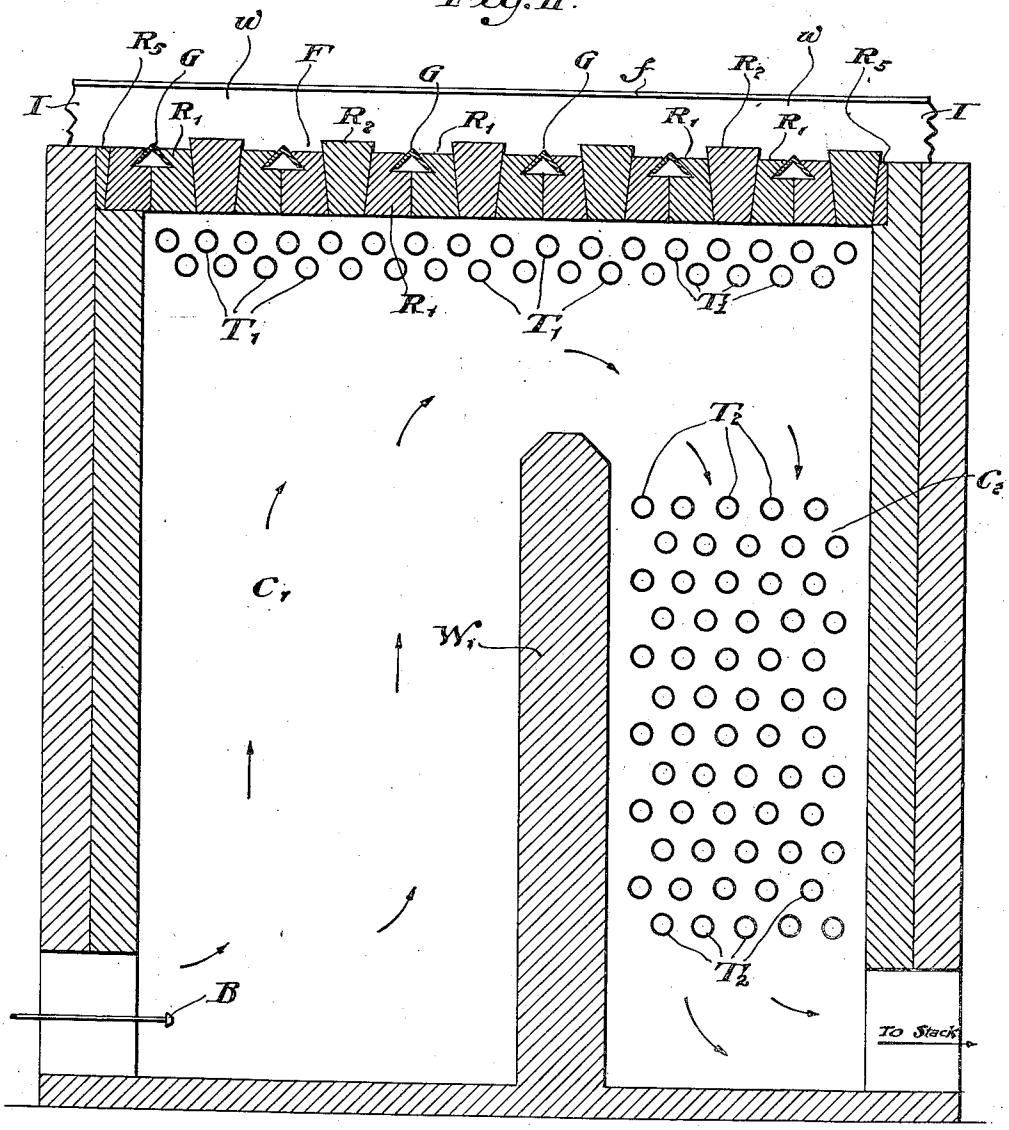
Inventor
Arthur E. Nash
By Cornelius L. E. Luet
his Attorney

Aug. 9, 1932. A. E. NASH 1,870,783

FURNACE WALL STRUCTURE

Filed May 18. 1928 3 Sheets-Sheet 3

Fig. 1.



Inventor
Arthur E. Nash
By Cornelius L. Eckert
his Attorney.

Patented Aug. 9, 1932 1,870,783

UNITED STATES PATENT OFFICE

ARTHUR E. NASH, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO ALCORN COMBUSTION COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF DELAWARE

FURNACE WALL STRUCTURE

Application filed May 18, 1928. Serial No. 278,706.

My invention relates to the structure of furnace walls, and particularly those of the type carried by or suspended from metal framework or supporting structure and utilized as the top wall or roof of a chamber; more particularly my invention relates to flat roofs or flat arches of furnaces or chambers of furnaces of steam generators, petroleum stills, petroleum heaters, particularly pipe stills, and similar heat transfer systems.

My structure is suited for use as the roof or top wall of a chamber within a furnace, or as the roof or top wall of a furnace or furnace chamber having one side exposed to the surrounding atmosphere. My structure is suitable, for example, for the roof or top wall, whether or not exposed to the external atmosphere, of a radiant heat chamber, or of a convection heat chamber, or of a chamber in which the absorption structure is heated partially by radiation and partially by convection.

Accordingly my structure is utilizable in furnaces generally, and in heat transfer systems such as disclosed in Letters Patent No. 1,591,431, July 6, 1926; in application Serial No. 164,682, filed January 31, 1927; and in application Serial No. 260,956, filed March 12, 1928; and is utilizable in similar and analogous systems.

In accordance with my invention, the roof or top wall, whether flat, as in flat roof or flat arch structures, inclined, or more or less arched, comprises a metal frame or supporting structure upon which are carried or suspended blocks of refractory material of the character hereinafter described suitably shaped for arch or like structures and some of them having recesses at or by which they are carried or hung upon supporting members of the metal frame or supporting structure.

Further in accordance with my invention some of the blocks, especially adjacent blocks on opposite sides of a supporting member, are provided with apertures or holes in which are adapted to engage the ends of locking pins or bars by recourse to which the arch or roof structure is held in position after removal of a key block during removal of one or more of the blocks for replacement or repair.

More particularly, an important feature of my invention is the nature of the material of which are constituted the aforesaid roof or arch elements or blocks. For these blocks or elements there are utilized refractory materials having a density materially lower than that of the usual fire brick or fire clay elements commonly utilized in roof or flat arch structures, and having materially higher heat insulating properties or relatively lower heat conductivities as compared with the usual fire brick or fire clay structures heretofore commonly used in flat arch or roof structures. By utilization of such materials the weight of the roof or arch per unit of thickness is greatly reduced, permitting lighter and less expensive metallic framework or supporting structure; the reduction in the temperature, to which the steel or other metal frame or supporting structure is subjected, avoids the necessity of extra weight in the frame or supporting structure heretofore essential to adequate strength in relations where it is subjected to high temperature, at which the metal has less supporting strength, due to the heat conducted to the frame or supporting structure through the blocks of higher heat conductivity; and there results also reduction of radiation losses to surrounding atmosphere. As a result of the lesser density and lower heat conductivity of the roof or flat arch elements or blocks, there is obtainable a less costly construction which at the same time relatively reduces the radiation losses, and correspondingly increases the overall thermal efficiency of the furnace.

Further in accordance with my invention there is utilized in combination with roof or arch structure of the material aforesaid having low density and low heat conductivity, heat absorption structure disposed adjacent thereto and intervening between it and a heating chamber.

My invention resides in characteristics and in features of construction and arrangement of the character hereinafter described and claimed.

For an understanding of my invention, and for an illustration of some of the various forms it may take, reference is to be had to the accompanying drawings, in which:

Fig. 1 is a vertical cross sectional view of a radiation-convection furnace embodying my invention.

Fig. 2 is a vertical sectional view of a modified form of furnace structure utilizing my invention.

Fig. 3 is a top plan view of my construction.

Fig. 4 is a vertical cross sectional view taken on the line 4—4 of Fig. 3.

Fig. 5 is a vertical sectional view taken on the line 5—5 of Fig. 3.

Figs. 6, 7, 8, 9 and 10 each comprises front and side elevational views of the various block forms utilizable in my construction.

Fig. 11 is a vertical cross sectional view of an open fired furnace embodying my invention.

Referring to Fig. 1, there is illustrated a furnace having a roof of flat arch structure F in accordance with my invention and constituting the top wall of a chamber Cv containing tubes or banks of tubes T heated both by convection and by radiation from some of the walls, such as the structure H and arch D, the intensity of application of heat, however, being preferably so distributed that excessively high temperatures throughout or locally are prevented. Within the furnace is a second chamber Cr containing the tubes or banks of tubes T1 heated substantially exclusively by radiation from the radiation combustion chamber K some of whose walls, particularly the upper and side walls, are composed of silicon carbide or other highly refractory material of suitably high, moderate or low heat conductivity. Each of the radiation combustion chambers K may be of any suitable structure and have any suitable composition for its walls, and may be such, for example, as described in the aforesaid application Serial No. 260,956. Adjacent the inlet to the chamber K is the burner B to or through which is delivered gaseous, liquid, or other fuel; the air for combustion enters through the duct A, and the hot gases and hot products of combustion pass through the chamber K, raising its radiating walls to suitably high temperature, as the temperature at which the walls are incandescent, thereby radiating heat to the tubes T1 disposed below the wall or baffle W. The hot gases pass from the radiation combustion chamber K upwardly through the perforated arch D into the chamber Cv and thence through the passage E to stack or other suitable destination In their passage through the chamber Cv the gases give up their heat either directly to the tubes or to the walls H which then radiate to the tubes T. Through tubes T is passed water or steam, in a steam generator, or petroleum or petroleum cut or product, in liquid or vapor phase, in a petroleum heater or pipe still, or in a cracking system. The water, steam or oil is thereafter passed through the tubes T1 of the absorption structure in the radiation chamber Cr, though it will be understood that the sequence may be reversed as between T and T1.

Referring to Fig. 2, the flat roof or flat arch F, embodying my construction, forms the roof or top wall of the radiant heat chamber Cr, through which there is applied to tubes T1 radiant heat derived from the walls of the radiation combustion chamber K provided with the air inlet duct A and burner B. The hot gases or hot products of combustion are delivered into the upwardly extending chamber Cv in which the tubes T are heated principally or substantially only by convection, the gases passing eventually to the stack S. The banks of tubes or absorption structures T and T1 may be traversed in either order by the water, steam, oil, petroleum or the like to be heated, vaporized, distilled or cracked.

The flat roof or flat arch structures comprise the metal frame or supporting system and the blocks of refractory material of low density and low heat conductivity.

The metal frame or supporting structure comprises steel I beams or channels I having the vertically extending webs *w* and the horizontally extending flanges *f*.

Resting at their ends upon the flanges *f* of widely separated beams I are the transversely extending members G, of steel or other metal, preferably in the form of angle irons, as illustrated, or of any other suitable shape or section, preferably rolled. These angle irons are placed preferably with their vertices uppermost.

In the illustrated embodiment of my structure there are utilized blocks R1, Fig. 6, pairs of which are disposed adjacent each other longitudinally of each angle iron G and the blocks of each pair are disposed on opposite sides of the angle iron; and between the blocks R1 carried by different angle irons are disposed the key blocks R2. The blocks R1 have the lateral recesses *r*1 conforming to the size and shape of the angle iron G, a pair of blocks R1 when closely adjacent each other embracing the angle iron as indicated in Figs. 1, 2 and 4. The sides of the blocks R1, opposite to those having the recesses *r*1, are tapered downwardly and outwardly to correspond to the downward and inward taper of the key blocks R2, Fig. 7, which latter key and hold all the blocks in the form of a flat arch or roof. As indicated in Fig. 5, adjacent the beams I, at the ends of the angle bars G, there are utilized blocks R3, Fig. 8, similar to the blocks R1 in that they have the lateral recesses *r*1 for receiving the angle bars

G, but of greater width, longitudinally of the bars G, to form L like portions extending under the beam structure I. Two blocks R3 on opposite sides of the beam structure serve completely to isolate it from the direct effect of heat from the chamber below. Between blocks R3, carried by adjacent bars G, are utilized key blocks R4, Fig. 9, similar to blocks R2, except that they have the lower L like projections, as in the case of blocks R3, to extend fully under the beam structure I.

Between the flat arch or roof proper and one or more of the side walls of the furnace structure there may be utilized also buffer or filler blocks R5 where indicated in Figs. 1 and 2, and having the shape indicated in Fig. 10.

As indicated in Figs. 3, 4 and 5 the blocks, such as R1 and R3 directly carried by or hung upon the angle bars G and enclosing them, may be provided with holes *h*, Fig. 4, into which may extend the downwardly turned ends of the clamping bars or locking pins P which may be utilized if and when desired, as of advantage in holding the roof blocks or elements in position after a key block or blocks, such as R2 or R4, are removed.

In the roof or arch structure of the character described the refractory roof elements or blocks are directly carried or supported by frame elements such as the angle bars G and the entire roof or arch structure is more or less free to yield or move because the supporting bars or angle irons G are merely supported on, preferably not fastened to, the beam members I, and the refractory shapes or blocks are more or less free to move or yield parallel to, i. e., longitudinally of, the supporting angle irons G. By removal of a key block, such as R2 or R4, either of the immediately adjacent hanging shapes or blocks, as R1 or R3, which are normally in contact with the key block, may be easily removed and replaced, and during the absence of any key block the bars or pins P, if used, will hold in place the related blocks.

In Fig.11 there is shown in vertical cross section an open fired furnace having the burner B in the combustion chamber C1 upwardly through which pass the hot gases and products of combustion over the upper end of the bridge wall W1 into the chamber C2 in which are disposed the tubes T_2 constituting a heat absorption structure heated principally or substantially entirely by convection. The gases pass downwardly though the chamber C2 and thence outwardly to stack. The roof structure F, of the character hereinbefore described, is carried by beams such as I resting upon suitable supports, such as the side walls of the furnace. A second heat absorption structure, as tubes T1, in one or more rows deep, is disposed on the under side of the roof F, extending throughout its entire area or a substantial portion thereof, and intervening between it and the current of gases through the furnace, and intervening also between the radiating walls, such as the side walls of the chamber C1, and the roof structure. When the tubes T1 are disposed in two or more superposed rows or tiers, and especially when the tubes of a lower row are directly below the spaces between tubes of an upper row, as indicated, the roof F is well shielded from radiation and free of erosion by the current gases. The fluid to be heated is passed through the heat absorption structures T1 and T2 in succession, in either sequence, as may be desired.

By an arrangement of the character illustrated by Fig. 11 the metallic supporting framework of the roof is insulated by the blocks R1, R2, etc., against the high temperatures which would otherwise be applied thereto because of the heat radiated from the hot walls and conducted thereto from the furnace gases. The heat absorption structure T1 prevents substantial or serious erosion of the elements or blocks of the roof by the hot furnace gases, and further prevents application to the roof blocks or elements of excessively high temperatures or temperatures of a magnitude they might not be able to withstand for prolonged periods.

A feature of great importance is the nature, composition or characteristics of the roof blocks such as R1—R4. They are of refractory material, such as fire clay, diatomaceous earth, or other suitable material, but have such lower density or relatively lighter weight and lower heat conductivity or higher heat insulating value as compared with the usual fire brick, fire clay, or similar refractories heretofore commonly used in roof and flat arch structures, as to afford marked practical advantages.

By preference the heat conductivity of the roof or arch elements or blocks in accordance with my invention is of the order of seven tenths or materially less of the heat conductivity of usual fire bricks, fire clay refractories or the like heretofore commonly used; and the density or weight is of the order of seven tenths or materially less of the density or weight of the normally used refractories, fire clay blocks, fire bricks or the like.

By way of example it may be stated that for the roof or arch blocks in accordance with my invention there may be used the material known as "Stopheat", composed largely or principally of diatomaceous earth, having a weight of about 40 pounds per cubic foot, as compared with about 145 pounds per cubic foot of standard fire brick or standard fire clay refractories, and having a heat conductivity of three tenths as compared with a heat conductivity of unity for standard fire brick or normally used fire clay refractories. Or there may be used for example "Infrax",

having a heat conductivity of about three tenths that of fire brick or fire clay and a weight of the order of 50 pounds per cubic foot. These materials have a relatively large proportion of voids, resulting in the low heat conductivity and low density or weight. When suitably strong in character, a material such as "Sil-o-cel" may be utilized for the arch or roof elements or blocks; it is a natural product cut in block or other shapes and usually calcined to remove organic impurities and moisture. leaving a porous siliceous mass of a heat conductivity of about three tenths that of fire clay or fire brick and a weight of about 30 pounds per cubic foot.

These materials and their equivalents, are herein classified as heat insulators as distinguished from the materials from which are made standard fire brick, fire clay refractories, and the like which, as commonly employed, though having to some extent the characteristic of insulation, have been utilized as and for their refractory characteristic or ability to withstand high or excessive temperatures, with which latter characteristic my invention is to a lesser degree concerned.

Use of materials of the character above described is of important practical advantage in that, because of their lower heat conductivity, the radiation of heat to the surrounding atmosphere is substantially reduced, thereby increasing the efficiency of the furnace. The lighter weight or lower density has the practical advantage that the beam elements, as I, and the supporting bars, as angle irons G, may be of smaller cross section or less weight, since their load is less than in the case of the normally used standard fire brick or fire clay refractory blocks. The size, weight and cost of the metal frame or supporting structure are further reduced because of the lower heat conductivity or insulating characteristic of the elements or blocks which materially reduce conduction of heat to the metal framework or supporting structure, thereby maintaining it relatively cool, and thereby avoiding the over- or extra size or weight necessarily given to frames or supports for the standard fire brick or fire clay refractory blocks whose heat conductivity is so high that its metal supporting framework attains a temperature at which the supporting strength of the metal is materially reduced.

As a result of use of refractory insulating blocks of the character described and preferred, the cost of the metal framework of the roof or flat arch is materially reduced; and the heat lost to surrounding atmosphere through the roof blocks or shapes is materially reduced, with consequent improved fuel economies. Roof or arch structure of the materials described is not subjected to high overall or local temperatures in those cases, illustrated, for example, in Figs. 1, 2 and 11, where heat absorption structure, such as tubes traversed by oil or other material under treatment, is disposed adjacent to the roof or arch structure and intervenes between it and a heating chamber. Under such circumstances, the material of the roof or arch structure is not subjected to excessive or extremely high temperatures, since the heat absorption structure in a sense shields the material from excessive temperatures, the heat absorption structure itself lowering the temperature in the vicinity of the roof or arch material. In addition, heat absorption structure so related to the roof or arch protects the material herein described, of low density and low heat conductivity, from serious or substantial erosion by furnace gases or flame.

The materials and structure described are of advantage in those relations where extremely high overall or local temperatures do not obtain, or where the temperatures are high but the roof or arch is not subjected to serious erosion by flame or gas.

For brevity in the appended claims the terms "low density" and "low conductivity" refer to densities and heat conductivities of the order of seven tenths and less of the density and conductivity of standard fire brick, fire clay refractories and the like; and the term "roof" comprehends a wall closure of a furnace or furnace chamber disposed either within the furnace or exposed to the atmosphere.

What I claim is:

1. Furnace roof structure comprising a metal supporting framework and blocks of refractory material, having a density and conductivity of the order of one-third of that of standard fire brick or fire clay refractories, carried by and insulating said framework constituting the entire depth of the roof structure and having their inner ends directly exposed to the interior of the furnace.

2. Furnace roof structure comprising carrier bars, recessed refractory blocks embracing and carried by a bar, a key block disposed between and locking the blocks carried by adjacent carrier bars, and a lock pin engaging recesses in the tops of the associated blocks carried by a bar and holding them in position upon removal of the key block.

3. Furnace wall structure comprising a metal supporting framework, and blocks of refractory material having a density and heat conductivity of the order of one third of that of standard fire brick or fire clay refractories, carried by said framework and directly exposed to the furnace interior.

4. A furnace adapted for use with very high temperatures, comprising a supporting wall structure of metal framework, and blocks of heat insulating material carried thereby and forming a interior wall of the furnace, said

blocks having a substantially lower density and a greater porosity, with substantially lower heat conductivity, than that of standard firebrick or fire clay refractories, whereby the necessity of using standard refractory materials of high density as a lining for the furnace is obviated.

ARTHUR E. NASH.